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Ductile - Ductile Beryllium Aluminum Metal Matrix Composite Manufactured by Extrusion

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1.0 Introduction

Beryllium-aluminum alloys are unique, in-situ ductile-ductile metal matrix composite alloys. Cast and extruded beryllium-aluminum composite alloys are expected to have a unique combination of properties that are attractive for applications such as ground and space based interceptor and tracking systems that require minimum weight, high stiffness, good damping capacity and thermal stability. Compared with other metal matrix composites, cast and extruded beryllium-aluminum composites are expected to have the advantages of: (1) lower cost; (2) significantly higher ductility; (3) higher temperature capability; (4) less directionality of properties; (5) applicability of all conventional metal processing techniques; and (6) joining by conventional welding and brazing technology.

The current program is designed to develop a method for extruding a cast beryllium-aluminum composite, establish a basis for estimating the properties that can ultimately be achieved with an optimized process, and produce an extruded structural shape of moderate complexity. Specific technical objectives are as follows:

1. Develop an extrusion process suitable for beryllium-aluminum composites that maximizes product yield, minimizes processing steps, gives good surface finish, and is suited for producing complex shapes.

2. Determine mechanical and physical properties to demonstrate potential.

3. Define potential for property enhancements and cost reductions that could be achieved through continued development of this technology.

2.0 Work Plan

The work covered by this program is divided into two main tasks and a number of subtasks. Task 1 involves the development of extrusion parameters. For this task, three ingots will be cast, each measuring approximately 47.5 mm diameter by approximately 200 mm length. The diameter of the ingots has been increased slightly from the original plan to ensure that a high quality surface finish can be achieved on the ingots prior to extrusion billet preparation. The ingots will be cast with a nominal composition of 65Be-33Al-2Ag (by weight percent). Each ingot will be cut in half to provide six cylindrical billets for extrusion.

Different pre-extrusion billet canning/coating techniques will be evaluated to determine the optimal conditions that produce extrusions having the best surface quality. The can or coating helps prevent surface cracking and aids lubrication.

Three billet preparation techniques will be evaluated. The first will be to enclose the billet in a metal sleeve or can. Sleeves of 6061 aluminum will be evaluated at thicknesses of 0.635 mm and 1.905 mm; a copper sleeve with a thickness of 1.905 mm will also be evaluated. The second billet preparation technique will be to plasma spray an aluminum alloy coating onto two billets, with coating thicknesses of 0.635 mm and 1.905 mm. The final billet surface will be plated with copper with a plated coating thickness of 0.635 mm.

The six billets will be extruded through a round die as a group using similar extrusion parameters. Extrusion parameters will be selected based on results from previous NMI IRAD work. The extruded rods will be evaluated primarily for the effects of billet preparation on surface finish. Overall product integrity will also be evaluated.

Task 2 will lead to development of the capability to extrude a structural shape of moderate complexity of beryllium-aluminum composite. Details of this task will be discussed in future reports.

3.0 Work Accomplished

Machining of casting molds has been accomplished for task 1 ingots. Casting of the three ingots for Task 1 has been scheduled for completion the week ending 11/4/94. The delay in casting of these ingots resulted from the change of ingot diameter, reported in section 2.0, which required machining of the new casting molds.

Aluminum and copper sheet have been obtained for billet canning required for Task 1. Plating and plasma spray vendors have been identified for billet preparation. Samples of beryllium-aluminum alloy have been sent to the

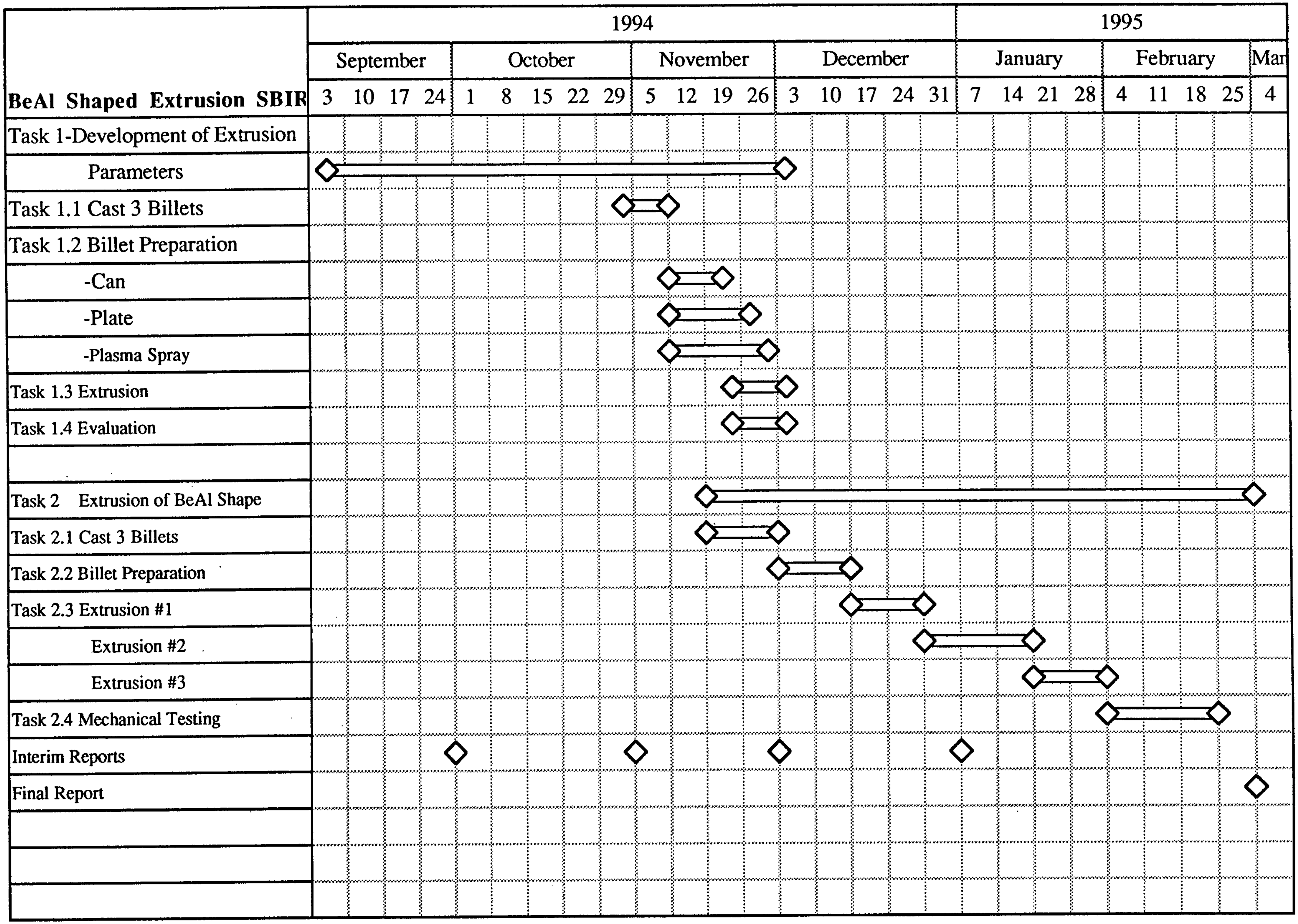
plating vendor for development of plating procedures designed to plate a uniform copper layer on the beryllium-aluminum with a plated coating thickness of 0.635 mm. The development of the plating procedures has been completed. An updated program schedule is attached.

4.0 Work Planned Through Next Reporting Period

Casting of the three Task 1 ingots is scheduled to be completed the week ending 11/4/94. Billet preparation, including canning, plating, and plasma spraying, is expected to be completed for the 6 billets for Task 1 by the middle of the next reporting period. Extrusion and evaluation will follow immediately as billet preparation is completed, to allow completion of Task 1 near the end of the next reporting period.

5.0 Conclusions

Work is underway for preparation of billets for Task 1 extrusions, which are designed to assist in the development of extrusion parameters for beryllium-aluminum alloys. Task 1 should be completed by the end of November. The development of extrusion technology for extrusion of beryllium-aluminum through a die of complex shape will follow.


BeAl Shaped Extrusion SBIR
1994
1995
September
October
November
December
January
February
Mar
3 10 17 24 1 8 15 22 29 5 12 19 26 3 10 17 24 31 7 14 21 28 4 11 18 25 4
Task 1-Development of Extrusion
Parameters
Task 1.1 Cast 3 Billets
Task 1.2 Billet Preparation
-Can
-Plate
-Plasma Spray
Task 1.3 Extrusion
Task 1.4 Evaluation
Task 2 Extrusion of BeAl Shape
Task 2.1 Cast 3 Billets
Task 2.2 Billet Preparation
Task 2.3 Extrusion #1
Extrusion #2
Extrusion #3
Task 2.4 Mechanical Testing
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Final Report